Learning Set 10: The Grasshopper Investigation

Overview: Learning Set 10 culminates several weeks of instruction and investigation into the concepts of Natural Selection. In learning sets 7-9, students were engaged in understanding how an organisms traits and the local environmental conditions play a large role in determining if the organism survives. Students learned that organisms are either fit for survival or they are selected against in nature. The environmental conditions can select certain traits indirectly causing those individuals in a population to become prolific, while other individuals with traits that are selected against lose nature’s battle of genetic dominance. During these following investigations students will build upon this concept of natural selection based on environmental conditions and genetic variations as they collect data from several different, yet connected, field and laboratory projects. Students will be exploring the following questions: **1)What evidence did we collect that supports the major concepts of natural selection with respect to the River Rouge grasshopper populations? 2)What genetic variations are present in the grasshopper populations, and is there evidence that some of those traits are trending toward preservation or elimination? 3) Is there evidence to support a theory that environmental conditions in the River Rouge Watershed are leading to differential survival and reproduction of chance inherited variations in grasshopper traits?** Students will be utilizing several different technologies to complete the following activities in lesson 10 such as Story Board presentations, GoAnime, Prezi presentations, Wiki site development, GPS technologies, digital photography, gaming simulations, Ponar sampling, NMR sample identification, smart phone technologies, digital microscopy, remote sensing, tagging, tree-cameras, Western Blot PCR analysis, and video production. The goal of the following series of investigations is to build a conceptual link between the processes of natural selection and the preservation or elimination of genetic variation due to the selecting factors in the environmental conditions.

This learning set consists of five explorative activities:

Learning Activity 10.1 Lubber grasshopper dissection (3 days)

Learning Activity 10.2 Natural selection simulation (3 days)

Learning Activity 10.3 Insect diversity of grasshopper populations of the River Rouge (3 days)

Learning Activity 10.4 Biodiversity of Michigan wooded area (2 days)

Learning Activity 10.5 Grasshopper Western Blot PCR analyses (3 days)

These investigations conclude with the production of a series of digital materials that synthesize the scientific explanation that supports, or disproves, the theory that environmental conditions in the River Rouge Watershed are leading to differential survival and reproduction of chance inherited variations in grasshopper traits.

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| Activity | Content Standard (HSCE) | Content Learning Performance | Technology Standard | Technology Learning Performance |
| 1 | B5.1a: Summarize the major concepts of natural selection (differential survival and reproduction of chance inherited variants, depending on environmental conditions). | Students will successfully dissect the Lubber Grasshopper, measure various body parts, record measurements in chart form, devise a phenotype chart that compares trait variation, analyzes the possibilities of differential survival as a function of chance inherited traits, and construct well written and visually correct representations of natural selection concepts utilizing various information technology applications. | NETS 1: Students demonstrate creative thinking, construct knowledge, and develop innovative products and processes using technology. | A) apply existing knowledge to generate new ideas, products, or processes.  B) create original works as a means of personal or group expression.  C) use models and simulations to explore complex systems and issues.  D) identify trends and forecast possibilities. |
| 2 | B5.1b: Describe how natural selection provides a mechanism for evolution. | Students will conduct a natural selection simulation in the field using various technological devices to record results and identify organisms. Students will then relate results of their simulation to the actual occurrence of natural selection in the University of Michigan-Dearborn field area, with respect to the factors they identified. |  |  |
| 3 | B5.1d: Explain how a new species or variety originates through the evolutionary process of natural selection. | Students will relate their field research results to the concepts of natural selection based on differential survival of randomly inherited traits. Students will analyze the occurrence of traits in the population of Rouge River grasshoppers. Students will analyze all biotic and abiotic factors from the surrounding region and related the results to possible natural selection factors. | NETS 4: Students use critical thinking skills to plan and conduct research, manage projects, solve problems and make informed decisions using appropriate digital tools and resources. | A) identify and define authentic problems questions for investigation.  B) plan and manage activities to develop a solution or complete a project.  C) collect and analyze data to identify solutions and / or make informed decisions.  D) use multiple processes and diverse perspectives to explore alternative solutions. |
| 4 | B5.1e: Explain how natural selection leads to organisms that are well suited for the environment. | Students will examine the University of Michigan Natural areas and determine if there is a theme for the diversity of organisms represented at varying distances from the Rouge River. Students will then use their knowledge of natural selection to predict why the organisms were found at various locations, making sure to discuss the ideas of selective survival. |  |  |
| 5 | B5.1g: Illustrate how genetic variations is preserved or eliminated from a population through natural selection (evolution) resulting in biodiversity. | Purposely left blank for this edt 514 activity 3 |  |  |

Learning Set 10 Preparation:

Time:

1) 10-13 45 minute periods

2) Three field trips to University of Michigan-Dearborn Natural Area and River Rouge Watershed/ Flood plain.

Materials:

1) Activity 10.1: Lubber grasshopper dissection.

* For each student group: one size fits all gloves, eye protection, lab aprons, 20 Lubber grasshopper specimens, one MacBook Air computer, one digital imaging dissection microscope, and two dissection kits and trays.
* For the class: LCD projector, cleaning supplies, paper towel, and smart board, classroom access to Prezi, Story Board, GoAnime, and Wiki website.

2) Activity 10.2: Natural selection simulation.

* For each student group: field book, digital SLR camera with ~18-270mm macro wide angle lens, Garmin Rino 120 GPS unit, MacBook Air computer, insect examination jars, and smart phone with Web access.
* For the class: LCD projector, smart board, classroom access to Prezi, Story Board, GoAnime, and Wiki website.

3) Activity 10.3: Diversity in grasshopper populations of the River Rouge.

* For each student/group: field book, pen, Rino GPS, Nikon digital camera with accessories, examination jars, smart phones with Web access, Ponar sampler, water quality kit, Secchi disk, and
* For the class: small boat, seven volunteers, 20 life vests, access to river area, transportation, projector, smart board, classroom access to Prezi, Story Board, GoAnime, and Wiki website.

4) Activity 10.4: Biodiversity of Michigan wooded areas.

* For each student: Students require field handbook, Garmin Rino GPS units, Nikon digital camera with macro lens, smart phones,
* For the class: Students require MacBook computers, LCD projector, smart board, classroom access to Prezi, Story Board, GoAnime, and Wiki website.

5) Activity 10.5: Grasshopper Western Blot PCR analyses.

* For each student: Purposely left blank for this edt 514 activity 4
* For the class:

**Learning Activity 10.1 Lubber grasshopper dissection**

Learning Activity 1 description:

Student groups will be dissecting several specimens of the Lubber Grasshopper and determining if there is evidence within the Lubber Grasshopper population of chance inherited variants. Student groups will utilize basic dissection tools as well as a digital imaging dissection microscope connected to a MacBook Air computer during the dissection to photograph and document the progress of the dissection as well as the measurements of possible variants. Student groups will chart their quantitative and qualitative results and report to the whole class the possible variant measurements recorded as well as photographic evidence using the class Wiki website. The Students will then produce digital artifacts for the Wiki using one of the three previously utilized forms of presentations; Prezi, GoAnime, or Story Board. With the total class acquired knowledge, uploaded to the Wiki, of the grasshopper population chance inherited variants students will construct a series of phenotype charts that relate the trait variation with the possible environmental conditions linked to the trait. Students will then discuss the various scenarios that led to differential survival and reproduction that would be necessary to culminate in such variants and publish them on the designated Wiki page. The students groups have prior experience using the various forms of technology presented in Learning Set 10, thus students will rely on their experiences from Learning Sets 3, 5, and 7 to incorporate the necessary technology components.

Learning Activity 1 Teacher Content Knowledge:

The Eastern Lubber Grasshopper is one of the most unique species of grasshopper in the United States. Residing in the south eastern region of the United States the Lubber can reach lengths of up to three inches and finds refuge in most any area that contain tall grasses, or, where suitable food supplies permit. Due to their sheer size and overall small size of the wings the Lubber grasshopper does not fly. Therefore, the Lubber uses it large legs to jump short distances to search for food, avoid predators, or find mates. Lubber grasshoppers have a distinctive smell and warning coloration for defense mechanisms and can create rather loud noises, which collectively scare burgeoning predators away.

Natural selection is the process of differential survival and reproduction of chance inherited variants, depending on environmental conditions. Several disruptions occur in natural with respect to genetic equilibrium disruption. Mutation, migration, genetic drift, and nonrandom mating are not discussed in this learning set. The final disruption, natural selection, has three main forms. Stabilizing selection, disruptive selection, and directional selection are relatively identifiable in populations such as the Lubber. Students will be able to determine the average form of a trait, the most extreme form of a trait, and the most extreme variation of the trait in question. With those observations students can direct their thoughts to the most appropriate selection processes for Lubber grasshoppers. Another form of selection, sexual selection, will be addressed in an application formative assessment pertaining to Peahen choice mating. Sexual selection was Charles Darwin's single greatest idea of his time because people of his era would have never accepted that females could control genetic selection. The people of Darwin's time were solely focuses on male competition as the predominant factor.

In natural selection, of the Lubber grasshopper, the traits most recognizable as selected for differential survival are the tibia and femur size, as well as forewing development. The small size of forewing and the increased size of femur and tibia created the genetic variation necessary to preserve the Lubber population in adverse conditions of drought (lack of local food), predation (warning coloration and sounds), and fire conditions (ability to escape).

Activity 10.1 Learning objectives and assessment criteria:

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| Content Objective (HSCE) | Language Objective | Assessment Criteria |
| B5.1a-Summarize the major concepts of natural selection (differential survival and reproduction of chance inherited variants, depending on environmental conditions). | Students will present a written and visual understanding of natural selection concepts utilizing several different types of computer based presentation formats.  Students will begin construction of a Wiki website that follows the course work as well as presents an answer for the driving questions of the unit.  Students will be able to produce a vocabulary rich technological artifact that describes the differential survival and reproduction of grasshopper inherited variants. | Students will successfully dissect the Lubber Grasshopper, measure various body parts, record measurements in chart form, devise a phenotype chart that compares trait variation, and analyzes the possibilities of differential survival as a function of chance inherited traits.  Students will construct well written and visually correct representations of natural selection concepts utilizing various information technology applications. |

Activity 10.1 NETS Technology Objectives:

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| --- | --- | --- |
| NETS objectives | NETS Learning performance | Technology Assessment Criteria and Integration |
| NETS 1: Students demonstrate creative thinking, construct knowledge, and develop innovative products and processes using technology. | A) apply existing knowledge to generate new ideas, products, or processes.  B) create original works as a means of personal or group expression.  C) use models and simulations to explore complex systems and issues. | Student group artifacts represent all necessary components of the lab work. There is sufficient qualitative and quantitative evidence to support the presentations and hypotheses produced on the Wiki. Students utilize accurate representations of natural selection content and provide evidence that discusses trait variations and environmental factors. |
| NETS 4: Students use critical thinking skills to plan and conduct research, manage projects, solve problems and make informed decisions using appropriate digital tools and resources. | B) plan and manage activities to develop a solution or complete a project.  C) collect and analyze data to identify solutions and / or make informed decisions. | Student groups will utilize technology in multiple forms in learning activity 1. The use of digital imaging dissection microscopes will assist students in performing more accurate measurements, allowing for very precise digital documentation of evidence and procedures, and for the seamless uploading capability of qualitative evidence to the class Wiki website. Student groups will also utilize various layers of presentation software to present their groups work on the class Wiki, which will allow for student developed differentiation of content and artifacts. Student groups will present to the class from their Wiki pages using the SMART Board LCD interface. The teacher will be able to interact with student artifacts virtually on the web as well as through direct formative assessment of lab work and presentation. |

Instructional sequence

Activity 10.1 Introduction: accessing prior knowledge

Introduce the learning set and access prior knowledge by asking the students about the driving question to the unit. Ask students: What was the driving question for our natural selection unit? What investigations have we completed so far that has tried to answer the driving question?

Student responses should include ideas such as: The driving question is **How have environmental conditions changed different populations on Earth?**  We have tried to answer this question by examining Russian investigations into genetic variations of common dog populations in China and Russian, to discover the origin of the genetic traits that makes Dog Man's best friend.

Direct students back to the various charts constructed in Learning Set 5 and 7 that lead students to the understanding of trait variation can be observed within populations, not just between species. Also, asks students to explain the timing of the change in trait variations seen in fruit fly experiments. Did change in trait happen immediately? Did the population change because it wanted to? Can individuals change traits in response to environmental changes?

Student responses should include ideas such as: The fruit fly traits changed pretty fast, but not immediately. The populations changed over time but we see it faster in fruit flies. No, populations do not make the choice to change. Individuals cannot change in response to environmental changes, but, populations can change over time.

Some students may have minor deficiencies in the prior knowledge necessary for successful production of learning artifacts in Learning Set 10. Correct these holes in content by directing students to the three differentiated learning centers. Students can explore the concepts of natural selection, genetic variation, or environmental conditions at three different learning centers. Each center will provide differentiated learning activities for students of different levels. Student will chose the activity that is best suited for their learning style and level.

Activity 10.1 Introduction: introduce the Lubber grasshopper dissection lab and mystery

Explain to students that over the next several days they will be dissecting several Lubber grasshoppers from one population. Discuss with students that scientists have long wondered about how the Lubber grasshopper has become such a large form of grasshopper. Was the Lubber a descendent of a large, but long lost, form of grasshopper insect that lived many years ago? Were there various environmental conditions over the life of the Lubber grasshopper populations that caused the large specimens to be selected for survival versus smaller forms of the Lubber? Did a meteor crash into Earth many years ago, which included a burst of gamma radiation, that cause a genetic mutation in the Lubber grasshopper populations we see today? Explain to the students that they will be dissecting the Lubber grasshoppers trying to discover if there is any direct evidence of environmental conditions that may have caused differential survival among the Lubber grasshopper populations.

Activity 10.1 Dissection and Presentation:

Student groups will be constructed of three students, which will be given 20 Lubber grasshoppers from the same population, eye protection, gloves, lab aprons, dissection supplies, digital imaging dissection microscope, MacBook Air to connect to the microscope and allow for digital documentation of the dissection, a small metal ruler, and access to Prezi, Story Board, GoAnime, Word, Excel, and the class Wiki website. Students will utilize the digital photography capabilities of the microscope software layer to record various samples and measurements of the Lubbers they dissect. The students groups will then record their results on the Wiki using Excel to create charts and copy them as pictures into the Wiki. Students groups will also utilize one other form of digital presentations to communicate their results to the class. Student groups will present their reports as a function of the Wiki website to the class utilizing the classroom interactive white board.

Activity 10.1 Cumulative Results Analysis:

Following the student presentations, begin a discussion that probes for understanding of the combined results from the entire class. Construct a large class level chart that includes all measurements from all specimens on the Wiki. Student groups will be responsible for uploading their averages to the chart and contributing content to the specified Wiki webpage. The students can then utilize the larger population data to create a phenotype chart that compares trait variants to possible environmental conditions, which could have caused differential survival and reproduction. Student groups would be responsible for creating a scientific explanation of why several traits, of their choice, were chosen for survival based on environmental conditions.

Activity 10.1 Concluding Discussions:

Discuss the possible scenarios that students have come up with. Allow time for all groups to report and create a class Prezi showing the various student brainstormed environmental conditions that may have caused the differential survival. Explain to students that over the next two weeks they will be obtaining evidence from multiple field experiments about the grasshopper populations of the River Rouge watershed. They will be obtaining evidence to answer the following questions: **1) What evidence did we collect that supports the major concepts of natural selection with respect to the River Rouge grasshopper populations? 2)What genetic variations are present in the grasshopper populations, and is there evidence that some of those traits are trending toward preservation or elimination? 3) Is there evidence to support a theory that environmental conditions in the River Rouge Watershed are leading to differential survival and reproduction of chance inherited variations in grasshopper traits?**

Activity 10.1 Teacher Content Knowledge:

The content in learning activity 1 is a very familiar subject matter to me. I have had extensive experience with Lubber grasshoppers and dissection methods. The natural selection content is also a major part of my educational background, which I have a very deep understanding of many variations of the grasshopper scenario as well as other organisms. Any instructor who teaches this subject matter must have a deep understanding of many different examples of natural selection in the real world. Conceptual knowledge is not enough because of the enormous size of misconceptions that revolve around natural selection and evolution. Teachers would also benefit from a deep understanding of selection event that have occurred throughout history, including the major extinction event.

Activity 10.1 Teacher Pedagogical Knowledge:

Learning set 1 utilizes small group setting, small group formative assessment techniques, whole group discussion, integration of technology, Biology dissection techniques, lab preparation and clean-up, lab safety techniques, computer integration techniques, digital microscopy techniques, website development, digital communication applications, microphotography, as well as midpoint discussion and assessment. Teachers must also be fluent in differentiation of material to various student levels so the creation of learning centers can be efficient and effective in increasing understanding of concepts. The use of these pedagogical techniques is paramount in today's digital world. Scientists communicate results digitally through online journals and share data via email, blogs, and interactive video conferencing. If our students are to compete on a customer driven playing field the integration of current technologies is again, paramount.

Activity 10.1 Teacher Technology Knowledge:

The technology used in learning activity 1 requires prior use and access before teaching the lessons. Digital microscopy and related software have to be installed and practiced with before teachers can successfully allow students to utilize the devices. Familiarization with MacBook Air photographic and video editing programs is a must. The use and classroom licensing of Prezi, Story Board, and GoAnime is required before the lesson can be taught. Teachers must be fluent with interactive white boards and LCD projection as well as the subsequent analysis of student technological presentation evaluation.

Activity 10.1 TPACK Analysis:

An inquiry based approach to learning Science concepts, connected with thoughtful and thorough discussion, is a very acceptable approach in Science Pedagogy. Current research from the University of Michigan and other Universities support such inquiry and discussion as one of the best methods of Science instruction at the K-12 level. The use of digital technologies used in this activity are highly engaging and current with today's youth. The entire project is based in the digital world, which is very similar to our students with smart phone technology today. Students can perform the entire learning assignment online if necessary using dissection simulation technology.

Activity 10.1 Assessment Plan:

Student learning will be assessed on presentations that incorporate all qualitative and quantitative evidence from the dissection lab, that supports natural selection through environmental conditions causing differential survival and reproduction of chance inherited variants. The student groups are responsible for collecting dissection lab results and recording them digitally. Groups are also responsible for the development of several digital communication artifacts that lead to the development of the class Wiki website pages that refer to Lubber grasshoppers. The following scoring rubric will be utilized to assess the performance quantitatively:

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| --- | --- | --- | --- |
| Student subtask | Weak artifact development | Acceptable artifact development | Strong artifact development |
| Dissection qualitative and quantitative evidence | 1 | 2 | 3 |
| IT-Presentation artifacts | 1 | 2 | 3 |
| Oral presentations | 1 | 3 | 5 |
| Wiki development | 1 | 3 | 5 |

(On the following pages several questions will be utilized for a formative assessment of natural selection concept development from the last several learning sets)

In addition to the technological artifacts created during learning activity 1 students will be asked to answer some application questions. Student questions are attached and so are scoring rubrics.

1) Give a descriptive explanation of the three common forms of Natural Selection. Use no more than 30 words to complete this task and construct and label three graphs to show each selection relationship. (6 pts)

Tentative point allocation for each form

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| --- | --- | --- | --- | --- |
| Student subtasks | Stabilizing Selection | Directional Selection | Disruptive Selection | Total Points |
| Explanation of Natural Selection forms | 1 | 1 | 1 | 3 |
| Graphical representation of Natural Selection forms | 1 | 1 | 1 | 3 |

2) Mariko Takahashi and [Toshikazu Hasegawa](http://beep.c.u-tokyo.ac.jp/) at the University of Tokyo in Japan studied peacocks and peahens in Izu Cactus Park, Shizuoka, from 1995 to 2001 to determine whether or not sexual selection played a role in peahen choice mating decisions. Their research concluded that tail length and number of eye spots played an insignificant role in peahen mating decisions, after observing over 250 successful mating situations. (8 pts, use additional paper if necessary)

* Explain in detail how Takahashi and Hasegawa's lack of observed evidence of sexual selection in peahen mating decisions is different than that of Charles Darwin.
* Describe how Charles Darwin believed competition and choice played a role in the male and female aspects of sexual selection and analyze why Takahashi and Hasegawa's results do not support those theories.
* Evaluate why Marian Petrie's experiments with peacocks sexual selection over a two year period indeed provided better scientific evidence for Darwin's theory of sexual selection, compared that of Takahashi and Hasegawa's. (Petrie's experiments with peacocks included the actual removal of eyespots and shortening of tail feathers, as well as, the subsequent mating patterns over a two year period).

b) Tentative scoring key:

Tentative point allocation

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| --- | --- | --- | --- |
| Student subtasks | Weak response | Acceptable response | Strong response |
| Compare/contrast Takahashi and Darwin | 0 | 1 | 2 |
| Explain competition and choice in sexual selection | 0 | 1 | 2 |
| Explain how Takahashi does not support sexual selection | 0 | 1 | 2 |
| Support for sexual selection from Petrie's experiment. | 0 | 1 | 2 |

**Learning Activity 10.2 Natural Selection Simulation**

Learning Activity 10.2 description:

Students will take a field trip to the University of Michigan -Dearborn Environmental Interpretive Center to play a natural selection field simulation. Students will be pretending to be various consumers in the River Rouge watershed food chain. Students will track down their food to better understand feeding patterns, predator prey interaction, camouflage, warning coloration, and how other natural selection factors control the retention or deletion of traits and genes in a population. Students will be recording their observations using field books, digital photography to record the traits of various individuals in a species they are feeding upon, and GPS geo-caching to record the locations of the organisms they eat. Students will utilize the data from their field books, digital media, and GPS results to construct a map later of their encounters. Students will subsequently produce a lab report using word and embedding photographs, charts, and graphs. Students will publish reports on the wiki. Students will construct scientific explanations that relate the results of their natural selection simulation to the various factors the researched in the field, and relate these connections to the various species development in the University of Michigan-Dearborn Interpretive Center location.

Students will then discuss the various scenarios that led to differential survival and reproduction that would be necessary to culminate in such variants and publish them on the designated Wiki page, with respect to specific organisms they have encountered. The students groups have prior experience using the various forms of technology presented in Learning Set 10, thus students will rely on their experiences from Learning Sets 3, 5, and 7 to incorporate the necessary technology components.

Learning Activity 10.2 Teacher Content Knowledge:

The University of Michigan-Dearborn Environmental Interpretive Center is located adjacent to approximately 70 acres of natural area along the River Rouge. The area has significant primary and secondary forested regions with a large portion of river that is uncontrolled, other than a water intake for the Henry Ford Estate power station. The river just south of the natural area was straightened over thirty years ago to increase the speed of the river, which drains the previously flooded areas of Fairlane Mall and the surrounding parking lots. The secondary forested region is approximately 400 years old and creates a wonderful backdrop for the Universities efforts to tap Sugar Maples and create syrup, as well as, a wonderful flow of yellow fall foliage.

Natural selection is the process of differential survival and reproduction of chance inherited variants, depending on environmental conditions. Several disruptions occur in nature with respect to genetic equilibrium disruption. Mutation, migration, genetic drift, and nonrandom mating are not discussed in this learning set. The final disruption, natural selection, has three main forms. Stabilizing selection, disruptive selection, and directional selection are relatively identifiable in the populations of insects at the University of Michigan-Dearborn natural area. Through their simulations, students will be able to observe the process of natural selection as it pertains to predator prey interactions, warning coloration, background foliage interactions and camouflage, and trait selection for removal from the population.

In these natural selection events the traits selected for differential survival will be related to the ability of the organism to interact with the surrounding background, thus surviving predation.

Activity 10.2 Learning objectives and assessment criteria:

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| Content Objective (HSCE) | Language Objective | Assessment Criteria |
| B5.1b: Describe how natural selection provides a mechanism for evolution. | Students will present a written and visual understanding of natural selection concepts utilizing several different types of computer based presentation formats and the field simulation.  Students will continue adding to the Wiki website that follows the course work as well as presents an answer for the driving questions of the unit.  Students will be able to produce a vocabulary rich technological artifact that describes the differential survival of insect and small animal populations in the University of Michigan-Dearborn natural areas. | Students will successfully perform a natural selection simulation field activity and collect various forms of data using traditional and digital recording methods. Students will analyzes the possibilities of differential survival as a function of chance inherited traits from the results of the simulation.  Students will construct well written and visually correct representations of natural selection concepts utilizing various information technology applications. |

Activity 10.2 NETS Technology Objectives:

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| --- | --- | --- |
| NETS objectives | NETS Learning performance | Technology Assessment Criteria and Integration |
| NETS 1: Students demonstrate creative thinking, construct knowledge, and develop innovative products and processes using technology. | A) apply existing knowledge to generate new ideas, products, or processes.  B) create original works as a means of personal or group expression.  C) use models and simulations to explore complex systems and issues. | Student group artifacts represent all necessary components of the lab work. There is sufficient qualitative and quantitative evidence to support the presentations and hypotheses produced on the Wiki. Students utilize accurate representations of natural selection content and provide evidence that discusses trait variations and environmental factors. |
| NETS 4: Students use critical thinking skills to plan and conduct research, manage projects, solve problems and make informed decisions using appropriate digital tools and resources. | B) plan and manage activities to develop a solution or complete a project.  C) collect and analyze data to identify solutions and / or make informed decisions. | Student groups will utilize technology in multiple forms in learning activity 2. The use of GPS units and digital SLR cameras with a macro lens will assist students in recording observations and performing non-lethal predator prey simulations, allowing for very precise digital documentation of evidence and procedures, and for the seamless uploading capability of qualitative evidence to the class Wiki website. Student groups will also utilize various layers of presentation software to present their groups work on the class Wiki, which will allow for student developed differentiation of content and artifacts. Student groups will present to the class from their Wiki pages using the SMART Board LCD interface. The teacher will be able to interact with student artifacts virtually on the web as well as through direct formative assessment of lab work and presentation. |

Instructional sequence

Activity 10.2 Introduction: accessing prior knowledge

Introduce the learning set and access prior knowledge by asking the students about the previous learning activity. Ask students: What were the driving factor for natural selection in the lubber grasshopper populations over time? What natural selection factors were recognized as the most important?

Student responses should include ideas such as: The factors were leg length and wing length. The most important was probably the leg length because the Lubber's could only jump, not fly. Therefore, leg length determined if individuals within the population survived or died thus changing the population over time.

Direct students back to the various Wiki pages constructed in learning activity 10.1. Using the smart board review some of the presentations uploaded to the Wiki. Ask the students several questions. Did change in trait happen immediately? Did the population change because it wanted to? Can individuals change traits in response to environmental changes?

Student responses should include ideas such as: The grasshopper traits changed pretty fast with fire events, but not immediately. The populations changed over time with multiple fire and predator prey event. No, Lubber grasshoppers did not make the choice to change. Individuals cannot change in response to environmental changes, but, populations can change over time.

Some students may have minor deficiencies in the prior knowledge necessary for successful production of learning artifacts in Learning Set 10. Correct these holes in content by directing students to the three differentiated learning centers. Students can explore the concepts of natural selection, genetic variation, or environmental conditions at three different learning centers. Each center will provide differentiated learning activities for students of different levels. Student will chose the activity that is best suited for their learning style and level.

Activity 10.2 Introduction: introduce the natural selection simulation field experiment.

Explain to the students that they will be taking a lab field trip to the University of Michigan-Dearborn Environmental Interpretive Center tomorrow to investigate natural selection through a predator prey simulation. The first part of the morning will included a two hour introduction to the Universities natural areas by the Interpretive Center Staff, which includes a guided tour that takes about one hour. After the guided tour the students will break into their groups to perform the predator prey simulation. Explain to the students that the simulation will incorporate the use of Nikon D3100 SLR cameras equipped with 18-270 Tamron Macro telephoto lens, Bower SD FN52 main and macro-ring flashes to be used to document the organisms they encounter. Explain that student groups will also be given one Garmin Rino-120 GPS unit to track the location that they encounter organisms, as well as, ensure that no groups become lost (Rino GPS units can track each other through the use of RF communication). Student groups will also utilize smart phones to aide in the identification of organisms they encounter. Today students will be designing their simulations using the predetermined criteria, which includes the prey they can safely encounter without harming the local ecosystem as well as the criteria for no-harm field work. Student groups will create charts to record data and preplan their trekking paths using satellite images of the University natural area.

Activity 10.2 Field Simulation Experiment:

Upon arrival to the Environmental Interpretive Center students will take part in a Center designed orientation activity. Students will also go on an introductory walk through the natural area guided by Interpretive Center staff. After the walk student groups will organize their resources and layout their plan to perform the natural selection simulation. Student groups will be required to check in at various times using their GPS tracking unit. During their simulations students will trek through the natural area making sure not to tread onto designated protected areas (other than the use of their telephoto lens). During the simulation students can photograph animal species that they might prey upon using only their camera and not touching. Students can utilize the specimen examination jars for insects they find, as well as, plant life they prey upon. Students will be able to take close examination photographs utilizing the macro lens and ring flash, which can then be included in their written lab reports. Student groups will be recording the type of organism they prey upon including the various traits of the organism. The groups will later compare the 'trait' fed upon most often within a species to determine if there are any traits that are being selected against based on predator prey interactions. Students will also research all species populations that inhabit the area and compare those populations to the organisms they fed upon to determine if there is a differential survival connection.

The students groups will then incorporate their results and lab reports to the Wiki, using Word and Excel to create final reports. Students groups will also utilize one other form of digital presentations to communicate their results to the class. Student groups will present their reports as a function of the Wiki website to the class utilizing the classroom interactive white board.

Activity 10.2 Cumulative Results Analysis:

Following the student presentations, begin a discussion that probes for understanding of the combined results from the entire class. Construct a whole class Wiki page that includes all the organisms photographed during the simulation. Student groups will be responsible for uploading their photographs and descriptions to the specified Wiki webpage. The students can then utilize the whole class data to construct various natural selection events that may have occurred over the last 50-400 years of the University natural area. Student groups would be responsible for creating a scientific explanation of why several traits, of their choice, were chosen for survival based on environmental conditions and predator prey interactions.

Activity 10.2 Concluding Discussions:

Discuss the possible natural selection events that students have come up with. Allow time for all groups to report and create a class Prezi showing the various student brainstormed environmental conditions that may have caused the differential survival. Ask the students if we have obtained evidence that may help us answer the driving questions: **1) What evidence did we collect that supports the major concepts of natural selection with respect to the River Rouge grasshopper populations? 2)What genetic variations are present in the grasshopper populations, and is there evidence that some of those traits are trending toward preservation or elimination? 3) Is there evidence to support a theory that environmental conditions in the River Rouge Watershed are leading to differential survival and reproduction of chance inherited variations in grasshopper traits?**

Student answers will vary based upon sexual selection and predator prey interactions.

Activity 10.2 Teacher Content Knowledge:

The content in learning activity 2 is a very familiar subject matter to me. This particular activity is an adaptation of an experiment that I performed years ago for undergraduate work, in a more student designed and technologically advanced format. The Environmental Interpretive Center at the University of Michigan-Dearborn is one of the most important external resources a Biology teacher could have. Any instructor who teaches this subject matter must have a deep understanding of many different examples of natural selection in the University natural area as well as a good partnership with the Center's staff. Teachers must complete several visits to the area prior to arriving just to get to know the different components of the 70 acres of nature. Conceptual knowledge is not enough because of the enormous size of the area. Teachers would also benefit from a deep understanding of all organisms that inhabit the area, or at least have access to websites that can identify the organisms. Such websites will also be necessary for students groups to identify individual organisms. In addition, it may be beneficial to the flow of the activity to have taken two prior trips to the Center. Student trips in Fall and Winter will set-up a great activity in the spring when life is popping in the area.

Activity 10.2 Teacher Pedagogical Knowledge:

Learning set 2 utilizes small group field work, small group formative assessment techniques, whole group discussion, integration of technology, Field Biology techniques, proper trekking techniques, no-harm examination, computer integration techniques, digital macro photography techniques, website development, digital communication applications, as well as midpoint discussion and assessment. Teachers must become fluent in the use of the Nikon D3100 and attachments, Garmin Rino-120 GPS, related geocaching techniques, GPS locating techniques, and field recording techniques. Teachers must also be fluent in differentiation of material to various student levels so the creation of learning centers can be efficient and effective in increasing understanding of concepts. The use of these pedagogical techniques is paramount in today's digital world. Scientists communicate results digitally through online journals and share data via email, blogs, and interactive video conferencing. Also, laboratory field work is a wonderful opportunity for students to incorporate and apply what they have learned throughout the unit.

Activity 10.2 Teacher Technology Knowledge:

The technology used in learning activity 2 requires prior use and access before teaching the lessons. Teachers must have prior experience with Digital SLR photography and related attachments before ever trying to allow students to work with them. Teachers must also become extremely familiar with the GPS technology and how to locate students groups using the Rino-120 before allowing students to trek around a 70 acre natural area. Familiarization with MacBook Air photographic and video editing programs is a must. The use and classroom licensing of Prezi, Story Board, and GoAnime is required before the lesson can be taught. Teachers must be fluent with interactive white boards and LCD projection as well as the subsequent analysis of student technological presentation evaluation.

Activity 10.2 TPACK Analysis:

An inquiry based approach to learning Science concepts, connected with thoughtful and thorough discussion, is a very acceptable approach in Science Pedagogy. Current research from the University of Michigan and other Universities support such inquiry and discussion as one of the best methods of Science instruction at the K-12 level. The use of digital technologies used in this activity are highly engaging and current with today's youth. The project is field-based using components from the digital world, which is a good application of what scientists may use in today's science field.

Activity 10.1 Assessment Plan:

Student learning will be assessed on presentations that incorporate all qualitative and quantitative evidence from the field simulation, that supports natural selection through environmental and ecosystem conditions causing differential survival and reproduction of chance inherited variants. The student groups are responsible for collecting results and recording them digitally. Groups are also responsible for the development of several digital communication artifacts that lead to the development of the class Wiki website pages that refer to natural selection simulation. The following scoring rubric will be utilized to assess the performance quantitatively:

|  |  |  |  |
| --- | --- | --- | --- |
| Student subtask | Weak artifact development | Acceptable artifact development | Strong artifact development |
| Field-work qualitative and quantitative evidence | 1 | 2 | 3 |
| IT-Presentation artifacts and organism photography with identification | 1 | 2 | 3 |
| Oral presentations | 1 | 3 | 5 |
| Wiki development | 1 | 3 | 5 |

(On the following page is a question that will be utilized as formative assessment of natural selection concept development during learning activity 10.2)

In addition to the technological artifacts created during learning activity 1 students will be asked to answer some application questions. Student questions are attached and so are scoring rubrics.

1) Explain how predator prey interactions intertwine with environmental factors to produce natural selection events in the University of Michigan-Dearborn Natural Area. Support your answer with three specific examples from your field work. Use no more than 30 words to complete this task and construct and label three graphs to show each selection relationship. (6 pts)

Tentative point allocation for each form

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Student subtasks | Weak response including only one supporting example with no reasoning using scientific principles | Acceptable response including two supporting examples and good reasoning using scientific principles | Strong response including three supporting examples and excellent reasoning using scientific principles | Total Points |
| Explanation of Natural Selection with respect to predator prey interactions and environmental conditions. | 1 | 1 | 1 | 3 |
| Use of three supporting examples from field-work | 1 | 1 | 1 | 3 |

**Learning Activity 10.3**

Learning Activity 10.3 description: Diversity in grasshopper populations of the Rouge River.

Learning Activity 10.3 is characterized by further field research and technology incorporation to better understand the primary driving questions. Students will be utilizing common sampling methods as well as integrating modern technology into those methods. In activity 10.3 the students will take a field trip to an accessible area of the Rouge River watershed in the Dearborn area to complete various group led field research projects. Prior to the field trip day students would have been given a research method to report on at the field site. Student groups are expected to be the experts on their research method(s).

Students groups will be sampling various factors in the area including water related factors, pollution, predators, food sources, grasshopper species, and variations within grasshopper populations. Students will record all variations and determine if there are any factors that have caused or possibly may cause differential survival within the grasshopper populations. Individual groups will perform grasshopper collection and identification with subsequent digital photography and microscopy, Ponar sampling for suspended pollutant identification, NMR imaging of grasshopper samples to possibly identify pollutant absorption, identification of grasshopper populations that are found in various levels of vegetation and distance from watershed to determine if there is a correlation among biodiversity and traits/species, as well as identification of the various biotic and abiotic factors that grasshoppers are utilizing for their life cycles.

Students will utilize the data from their field books, digital media, and experimental lab results to construct a report later of their results. Students will subsequently produce a whole class lab report using word and embedding photographs, charts, and graphs. Students will publish the combined report on the wiki. Students will construct scientific explanations that relate the results of their findings to the various factors that may have led to differential survival of the grasshopper populations of the Rouge River.

Students will then discuss the possible scenarios that may have led to differential survival and reproduction of Rouge River grasshoppers. Student groups will also be responsible for publishing their groups observations, results, and scientific explanations to the wiki. The students groups have prior experience using the various forms of technology presented in Learning Set 10, thus students will rely on their experiences from Learning Sets 3, 5, and 7 to incorporate the necessary technology components.

Learning Activity 10.3 Teacher Content Knowledge:

The University of Michigan-Dearborn Environmental Interpretive Center is located adjacent to approximately 70 acres of natural area along the River Rouge. The area has significant primary and secondary forested regions with a large portion of river that is uncontrolled, other than a water intake for the Henry Ford Estate power station. The river just south of the natural area was straightened over thirty years ago to increase the speed of the river, which drains the previously flooded areas of Fairlane Mall and the surrounding parking lots. The secondary forested region is approximately 400 years old and creates a wonderful backdrop for the Universities efforts to tap Sugar Maples and create syrup, as well as, a wonderful flow of yellow fall foliage. The region has several tall grass areas just adjacent to the River Rouge, which will be necessary for grasshopper research. The best area for Ponar sampling would be south of the straightened portion of the river on the slow side of the first initial bend in the river, which would cause suspended sediment to drop out of solution to the river bed due to the decreasing speed of the river. These areas can be accessed from the Fairlane Mall parking lot or the University Parking lot. If these areas do not work strategically with a student population other regions of the River Rouge can be accessed in Dearborn, that are more accessible.

Ponar samples can be taken both from the rivers side and the middle of the river, using a small boat. This will broaden the scope and sample size ensuring an accurate picture of sediment quality. Water samples can be taken using Secchi Disks for turbidity, dissolved oxygen sensors, pH meters, nitrogen and phosphorus sampling for nutrient analysis using basic water testing kits, temperature, and hydraulic flow using a simple Orange velocity test. Students capturing grasshoppers will practice no harm techniques using sample jars for examination with digital photographic resources. One sample from each population examined will be kept for DNA analysis in the lab in activity 5.

Natural selection is the process of differential survival and reproduction of chance inherited variants, depending on environmental conditions. River rouge grasshopper populations should show differentiation in traits within a population, as well as, differentiation of habitat along the river. Some populations will be more represented along the river bed while others will only be found feeding on various native species plants farther up the flood plain. Tall grasses and golden rod will provide a wonderful area to find grasshoppers along the river. Similar to the Lubber grasshoppers in activity one students will recognize that Rouge River grasshoppers vary in color, femur size, wing size, habitat, feeding pattern, predation, and pollutant bioaccumulation. Students will be determining which of these factors could possibly cause differential survival and subsequent natural selection.

In these natural selection events the traits selected for differential survival will be related to the ability of the grasshopper to survive these variable conditions present at the Rouge River flood plain.

Activity 10.3 Learning objectives and assessment criteria:

|  |  |  |
| --- | --- | --- |
| Content Objective (HSCE) | Language Objective | Assessment Criteria |
| B5.1d: Explain how a new species or variety originates through the evolutionary process of natural selection. | Students will present a written and visual understanding of natural selection concepts, which may occur in Rouge River grasshoppers, utilizing several different types of computer based presentation formats.  Students will continue adding to the Wiki website that follows the course work as well as presents an answer for the driving questions of the unit.  Students will be able to produce a vocabulary rich technological artifact that describes the differential survival within the Rouge River grasshopper populations that can account for the diversity of trait and species. | Students will successfully report on their research methods prior to taking part in the field research.  Students will subsequently apply traditional research methods in the field experiment incorporating technological devices to supplement results gathering and analysis.  Students will construct well written and visually correct representations of natural selection concepts utilizing various information technology applications with respect to the field research results, and apply those results to the entire class analysis of the grasshopper population possible evolution. |

Activity 10.3 NETS Technology Objectives:

|  |  |  |
| --- | --- | --- |
| NETS objectives | NETS Learning performance | Technology Assessment Criteria and Integration |
| NETS 1: Students demonstrate creative thinking, construct knowledge, and develop innovative products and processes using technology. | A) apply existing knowledge to generate new ideas, products, or processes.  B) create original works as a means of personal or group expression.  C) use models and simulations to explore complex systems and issues. | Student group artifacts represent all necessary components of the lab work. There is sufficient qualitative and quantitative evidence to support the presentations and hypotheses produced on the Wiki. Students utilize accurate representations of natural selection content and provide evidence that discusses trait variations and environmental factors. |
| NETS 4: Students use critical thinking skills to plan and conduct research, manage projects, solve problems and make informed decisions using appropriate digital tools and resources. | B) plan and manage activities to develop a solution or complete a project.  C) collect and analyze data to identify solutions and / or make informed decisions. | Student groups will utilize technology in multiple forms in learning activity 3. Student groups will utilize Ponar samplers, water quality kits, Pasco probes, and Secchi disks. The use of GPS units and digital SLR cameras with a macro lens will assist students in recording observations and performing non-lethal sample analysis, allowing for very precise digital documentation of evidence and procedures, and for the seamless uploading capability of qualitative evidence to the class Wiki website. Student groups will also utilize various layers of presentation software to present their groups work on the class Wiki, which will allow for student developed differentiation of content and artifacts. Student groups will present to the class from their Wiki pages using the SMART Board LCD interface. The teacher will be able to interact with student artifacts virtually on the web as well as through direct formative assessment of lab work and presentation. |

Instructional sequence

Activity 10.3 Introduction: accessing prior knowledge

Introduce the learning set and access prior knowledge by asking the students about the previous learning activity. Ask students: What natural selection events were you simulating last week at the University Natural Areas? How would your presence as a predator changed the insect populations that you encountered?

Student responses should include ideas such as: We were simulating predator prey interactions. We couldn't find prey that may have blended into the background as easy as prey that wasn't. The organisms we encountered would have their DNA removed from the population. Therefore their traits would not be evident in future populations.

Direct students back to the various Wiki pages constructed in learning activity 10.2. Using the smart board review some of the presentations uploaded to the Wiki. Ask the students several questions. Would this change in trait happen immediately? Is the population you encountered in your simulation changing because it wants to? Can individuals change traits in response to you preying upon them? Can they camouflage themselves so you will not get them next time?

Student responses should include ideas such as: The populations would change slowly over time, however, if I eat enough of them this year the population may be quite different next year. This trait won't happen overnight but maybe noticeable weeks after. The insects I ate can't change their color will not change next time, mostly because I ate them and they are there anymore.

Explain to students today that they will be examining one populations of grasshoppers that live along the Rouge River to determine if there is any differential survival and difference in traits. Along with the trait identification we will be determining possible environmental factors that could cause natural selection events that have led or may lead to an evolutionary change in the population. We will again be using very familiar technology today as well as some new technology. Each group will be presenting their field research methods today before we begin.

Activity 10.3 Introduction: introduce the Rouge River Grasshopper field experiment.

Explain to the students that they will be taking a lab field trip to the University of Michigan-Dearborn tomorrow to investigate natural selection through a predator prey simulation. The first part of the morning will included a one hour introduction to the various field methods that are being used by the student groups. Each group is required to be the local expert on each method and the science behind the methods. After the group presentations the students will be organizing by group and adult group leader, then heading out to their designated field area. Explain to the students that the field research will incorporate the use of Nikon D3100 SLR cameras equipped with 18-270 Tamron Macro telephoto lens, Bower SD FN52 main and macro-ring flashes to be used to document the organisms they encounter. Explain that student groups will also be given one Garmin Rino-120 GPS unit to track the location that they encounter organisms, as well as, ensure that no groups become lost (Rino GPS units can track each other through the use of RF communication). Student groups will also utilize smart phones to aide in the identification of organisms they encounter. Today student groups will be maintaining safety procedures and no harm trekking tactics as well as group member monitoring. All Group members performing river analyses will be required to wear life preservers at all times, and other members when they are within 5 feet of the river will be required to wear life vests also.

Activity 10.3 Field experiments:

All student groups will be utilizing the Nikon digital cameras and related accessories utilized during activity two to document their progress and record the data. Student groups will also be using the Rino-GPS radio units to stay in touch and document location of research. Each student will also be required to record all field research and keep a journal of their activities in their field book.

Ponar samples will be undertaken using the Ponar attached to a long rope. Students will lower the Ponar into the water until they reach the bottom of the river, then they will engage the Ponar and bring the sediment up to acquire a sample in labeled jar. The groups performing Ponar samples will also be completing water quality analyses. They will be testing for dissolved oxygen and temperature using the Pasco probes, water turbidity using the Secchi Disks, river velocity using a orange and stop watch, and nitrogen and phosphorus sampling for nutrient analysis using basic water testing kits. The group will return the Ponar samples and water samples to the University of Michigan-Dearborn to be analyzed by Chemistry students using Nuclear Magnetic Resonance imaging to determine the type of pollutants present in the samples. For this activity there will be two students groups, one groups will perform analysis near the river side and the other will use the aluminum boats provided by watercraft volunteers.

Three student groups will perform the grasshopper analyses. Each group will take a particular area of the river side to look for grasshoppers. Groups will collect grasshoppers using butterfly nets and placing them in sample jars for examination. Groups will record the approximate femur length, wing length, color, eye color and size, antenna size and shape, and abdomen segments and color. Student groups will also keep one example of grasshoppers exhibiting differential traits, not to exceed six total grasshoppers between all groups. This will require group communication and decision making about the grasshoppers to keep. The grasshoppers will be kept alive until activity five when they will be utilized in the DNA examination.

Each student group will be identifying the abiotic and biotic factors in the local ecosystem that affect the differential survival of the grasshopper populations. This group will be using digital photography and microscopy to analyze all factors and record digitally. Students will analyze these factors against the documented regional biotic and abiotic factors to determine if there are any large discrepancies that may account for differences in trait among the Rouge River grasshopper populations and other locations in the region (at a later date several samples of grasshoppers from a different location could be analyzed and compared against the current samples).

Student groups will record all their data digitally and traditionally in their field books. Results will be brought back to the lab and analyzed. Student groups will be required to write a report on their results and construct scientific explanations based on the entire class analysis of data.

The students groups will then incorporate their results and lab reports to the Wiki, using Word and Excel to create final reports. Students groups will also utilize one other form of digital presentations to communicate their results to the class. Student groups will present their reports as a function of the Wiki website to the class utilizing the classroom interactive white board.

Activity 10.3 Cumulative Results Analysis:

Following the student presentations, begin a discussion that probes for understanding of the combined results from the entire class. Construct a whole class Wiki page that includes all the photographic representations of the research methods, abiotic and biotic factors, grasshopper species, differences in traits within populations, differences in grasshoppers based on location of the watershed, among other items that were photographed. Student groups will be responsible for uploading their photographs and descriptions to the specified Wiki webpage. The students can then utilize the whole class data to construct various natural selection events that may have occurred over the last 20-40 years of the Dearborn watershed that drains to that particular are of the Rouge River. Student groups would be responsible for creating a scientific explanation of why several traits identified were chosen for survival based on the various factors explored during the field experiment.

Activity 10.3 Concluding Discussions:

Discuss the possible natural selection events that students have come up with. Allow time for all groups to report and create a class Prezi showing the various student brainstormed environmental conditions that may have caused the differential survival. Ask the students if we have obtained evidence that may help us answer the driving questions: **1) What evidence did we collect that supports the major concepts of natural selection with respect to the River Rouge grasshopper populations? 2)What genetic variations are present in the grasshopper populations, and is there evidence that some of those traits are trending toward preservation or elimination? 3) Is there evidence to support a theory that environmental conditions in the River Rouge Watershed are leading to differential survival and reproduction of chance inherited variations in grasshopper traits?**

Student answers will vary based upon the factors they uncover in the field.

Activity 10.3 Teacher Content Knowledge:

The content in learning activity 3 is a very familiar subject matter to me. This particular activity is an adaptation of an experiment that I performed years ago for undergraduate work, in a more student designed and technologically advanced format. Teachers must complete several visits to the area prior to arriving just to get to know the different components of the 70 acres of nature and the river area around Fairlane Mall. Conceptual knowledge is not enough because of the enormous size of the area. Teachers would also benefit from a deep understanding of all organisms that inhabit the area, or at least have access to websites that can identify the organisms. Such websites will also be necessary for students groups to identify individual organisms. In addition, it may be beneficial to the flow of the activity to have taken two prior trips to the Center. Student trips in Fall and Winter will set-up a great activity in the spring when life is popping in the area. Teacher content knowledge of the various research methods is necessary as well as pre-training for adult volunteers. The teacher will need to become knowledgeable about the current research already published about the Rouge River and sedimentary pollutants. The teacher will also have to initialize a relationship with the Chemistry Professor or Dean of Science at the University of Michigan-Dearborn in order to complete NMR analyses with the assistance of college students.

Activity 10.3 Teacher Pedagogical Knowledge:

Learning set 3 utilizes small group field work, small group formative assessment techniques, whole group discussion, integration of technology, Field Biology techniques, proper trekking techniques, no-harm examination, computer integration techniques, digital macro photography techniques, website development, digital communication applications, as well as midpoint discussion and assessment. Teachers must become fluent in the use of the Nikon D3100 and attachments, Garmin Rino-120 GPS, related geocaching techniques, GPS locating techniques, Ponar sampling, water quality testing, and field recording techniques. Teachers must also be fluent in differentiation of material to various student levels so the creation of learning centers can be efficient and effective in increasing understanding of concepts. The use of these pedagogical techniques is paramount in today's digital world. Scientists communicate results digitally through online journals and share data via email, blogs, and interactive video conferencing. Also, laboratory field work is a wonderful opportunity for students to incorporate and apply what they have learned throughout the unit.

Activity 10.3 Teacher Technology Knowledge:

The technology used in learning activity 3 requires prior use and access before teaching the lessons. Teachers must have prior experience with Digital SLR photography and related attachments before ever trying to allow students to work with them. Teachers must also become extremely familiar with the GPS technology and how to locate students groups using the Rino-120 before allowing students to trek around a 70 acre natural area or rivers edge. Familiarization with MacBook Air photographic and video editing programs is a must. The use and classroom licensing of Prezi, Story Board, and GoAnime is required before the lesson can be taught. Teachers must be fluent with interactive white boards and LCD projection as well as the subsequent analysis of student technological presentation evaluation.

Activity 10.3 TPACK Analysis:

An inquiry based approach to learning Science concepts, connected with thoughtful and thorough discussion, is a very acceptable approach in Science Pedagogy. Current research from the University of Michigan and other Universities support such inquiry and discussion as one of the best methods of Science instruction at the K-12 level. The use of digital technologies used in this activity are highly engaging and current with today's youth. The project is field-based using components from the digital world, which is a good application of what scientists may use in today's science field. Activity three also includes the use of low and high-tech scientific tools such as testing probes and water sampling devices. The use of both together gives the students great advantage in understanding the technical aspects of scientific field research methods.

Activity 10.3 Assessment Plan:

Student learning will be assessed on presentations that incorporate all qualitative and quantitative evidence from the field research, that supports natural selection through environmental and ecosystem conditions causing differential survival and reproduction of chance inherited variants. The student groups are responsible for collecting results and recording them digitally. Groups are also responsible for the development of several digital communication artifacts that lead to the development of the class Wiki website pages that refer to grasshopper field research. The following scoring rubric will be utilized to assess the performance quantitatively:

|  |  |  |  |
| --- | --- | --- | --- |
| Student subtask | Weak artifact development | Acceptable artifact development | Strong artifact development |
| Field-work qualitative and quantitative evidence | 1 | 2 | 3 |
| IT-Presentation artifacts and organism photography with identification | 1 | 2 | 3 |
| Oral presentations | 1 | 3 | 5 |
| Wiki development | 1 | 3 | 5 |

Activity 10.3: Assessment Questions: In addition to the technological artifacts created during learning activity 3 students will be asked to answer some application questions. Student questions are attached and so are scoring rubrics.

1) Explain how predator prey interactions intertwine with environmental factors to produce natural selection events in the Rouge River grasshopper populations. Support your answer with three specific examples from your field work. Use no more than 30 words to complete this. (6 pts)

Tentative point allocation for each form

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Student subtasks | Weak response including only one supporting example with no reasoning using scientific principles | Acceptable response including two supporting examples and good reasoning using scientific principles | Strong response including three supporting examples and excellent reasoning using scientific principles | Total Points |
| Explanation of Natural Selection with respect to predator prey interactions and/or abiotic and biotic factors. | 1 | 1 | 1 | 3 |
| Use of three supporting examples from field-work | 1 | 1 | 1 | 3 |

2) Describe you research methods in the field experiment. Explain what biotic or abiotic factors uncovered in the field support differential survival in the Rouge River grasshopper population. Support your answer with three specific examples from your field work. Use no more than 30 words to complete this task. (6 pts)

Tentative point allocation for each form

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Student subtasks | Weak response including only one supporting example with no reasoning using scientific principles | Acceptable response including two supporting examples and good reasoning using scientific principles | Strong response including three supporting examples and excellent reasoning using scientific principles | Total Points |
| Explanation of Natural Selection with respect to predator prey interactions and/or abiotic and biotic factors. | 1 | 1 | 1 | 3 |
| Use of three supporting examples from field-work | 1 | 1 | 1 | 3 |

3) The State of Wisconsin began a plant and animal restoration project years back to fight the devastating loss of prairie land that had occurred in the State's Southern and Western Counties over 150 years ago. State Natural Resource officials used many potent DNA analyses as well as animal and plant species population studies to determine the effectiveness of the program. The most important natural factor, however, the Department of Natural Resources employed to study the program's effectiveness was actually the predominance of the Red Legged Grasshoppers. Red Legged Grasshoppers were once ubiquitous through those regions of Wisconsin but their numbers had diminished significantly during the prairie loss period. Please following components using 30 words or less for each prompt. (8 pts, use additional paper if necessary)

* Why would the presence of Red Legged grasshoppers in the newly restored and older remnant prairie lands suggest that the restoration project was indeed successful?
* How does the Red Legged Grasshopper prairie land scenario represent a natural selection event? Could this "natural selection" event actually be considered something different, something un-natural?
* Why was it important for the Human population to restore the prairie lands ecosystems? How could the Department of Natural Resources in Wisconsin utilize technology in their efforts to analyze the Red Legged grasshopper populations throughout the State? (Realizing that counting grasshoppers would be a daunting task on a State-Wide level)

b) Tentative scoring key:

Tentative point allocation

|  |  |  |  |
| --- | --- | --- | --- |
| Student subtasks | Weak response | Acceptable response | Strong response |
| Analysis of why Red-Legged grasshoppers are suitable for analyzing the restoration's effectiveness | 0 | 1 | 2 |
| Proper synthesis of natural selection vs. un-natural selection. | 0 | 1 | 2 |
| Explain how technology can be incorporated based on their recent applications of technology. | 0 | 1 | 2 |

**Learning Activity 10.4 Biodiversity of Michigan Wooded Areas**

Learning Activity 10.4 description:

Learning Activity 10.4 is characterized by further field research and technology incorporation to better understand the primary driving questions. Students will be utilizing common sampling methods as well as integrating modern technology into those methods. In activity 10.4 the students will take a field trip to an accessible area of the Rouge River watershed in the Dearborn area to complete various group led field research projects.

Students groups will be collecting data utilizing various sampling methods at different distances from the Rouge River. Each student group will be gathering data on several different insect, animal, plant, micro-organism, and fungal organisms at each of their sampling areas. Students will also be gathering photographic evidence from the tree-cameras set in place one week prior by the teacher and Interpretive Center Staff. Students will use the GPS units, digital cameras, and smart phones to gather data, analyze organisms, and record information from the study. Students will also take micro-organism samples in glass sampling jars for microscopic examination later (Optional is the use of field microscopes if they are available).

Students will utilize the data from their field books, digital media, and experimental lab results to construct a report later of their results. Students will subsequently produce a whole class lab report using word and embedding photographs, charts, and graphs. Students will publish the combined report on the wiki. Students will construct scientific explanations that relate the results of their findings to the various factors that may have led to differential survival and reproduction of Rouge River organisms, as their survival related to their distance from the Rouge River.

Students will then discuss the possible scenarios that may have led to differential survival and reproduction of Rouge River organisms, as their survival related to their distance from the Rouge River. Student groups will also be responsible for publishing their group’s observations, results, and scientific explanations to the wiki. The students groups have prior experience using the various forms of technology presented in Learning Set 10, thus students will rely on their experiences from Learning Sets 3, 5, and 7 to incorporate the necessary technology components.

Learning Activity 10.4 Teacher Content Knowledge:

The University of Michigan-Dearborn Environmental Interpretive Center is located adjacent to approximately 70 acres of natural area along the River Rouge. The area has significant primary and secondary forested regions with a large portion of river that is uncontrolled, other than a water intake for the Henry Ford Estate power station. The river just south of the natural area was straightened over thirty years ago to increase the speed of the river, which drains the previously flooded areas of Fairlane Mall and the surrounding parking lots. The secondary forested region is approximately 400 years old and creates a wonderful backdrop for the Universities efforts to tap Sugar Maples and create syrup, as well as, a wonderful flow of yellow fall foliage.

The area consists of a primary and secondary forest containing the river and a small lake. The student groups will have to spread out over the entire region to include all of these areas in their study. Groups should not be too close to each other so they can get better overall results when the groups combine data later in the lab.

Natural selection is the process of differential survival and reproduction of chance inherited variants, depending on environmental conditions. River rouge populations should show differentiation in species along the river. Some populations will be more represented along the river bed while others will only be found feeding on various native species plants farther up the flood plain. Student groups will photograph all organisms they find during their sampling methods. Students will be collecting soil and standing water samples also. Students will examine their data more intuitively in the lab, as well as research the organisms they find to determine if there are reasons the organism was found where it was with regards to the river. Students will also be examining various traits of each organism to determine which of these factors could possibly cause differential survival and subsequent natural selection.

Activity 10.4 Learning objectives and assessment criteria:

|  |  |  |
| --- | --- | --- |
| Content Objective (HSCE) | Language Objective | Assessment Criteria |
| B5.1d: Explain how a new species or variety originates through the evolutionary process of natural selection. | Students will present a written and visual understanding of natural selection concepts, which may occur in Rouge River populations, utilizing several different types of computer based presentation formats.  Students will continue adding to the Wiki website that follows the course work as well as presents an answer for the driving questions of the unit.  Students will be able to produce a vocabulary rich technological artifact that describes the differential survival within the Rouge River populations that can account for the diversity of trait and species. | Students will successfully report on their research methods prior to taking part in the field research.  Students will subsequently apply traditional research methods in the field experiment incorporating technological devices to supplement results gathering and analysis.  Students will construct well written and visually correct representations of natural selection concepts utilizing various information technology applications with respect to the field research results, and apply those results to the entire class analysis of the population diversity. |

Activity 10.4 NETS Technology Objectives:

|  |  |  |
| --- | --- | --- |
| NETS objectives | NETS Learning performance | Technology Assessment Criteria and Integration |
| NETS 1: Students demonstrate creative thinking, construct knowledge, and develop innovative products and processes using technology. | A) apply existing knowledge to generate new ideas, products, or processes.  B) create original works as a means of personal or group expression.  C) use models and simulations to explore complex systems and issues. | Student group artifacts represent all necessary components of the lab work. There is sufficient qualitative and quantitative evidence to support the presentations and hypotheses produced on the Wiki. Students utilize accurate representations of natural selection content and provide evidence that discusses trait variations and environmental factors. |
| NETS 4: Students use critical thinking skills to plan and conduct research, manage projects, solve problems and make informed decisions using appropriate digital tools and resources. | B) plan and manage activities to develop a solution or complete a project.  C) collect and analyze data to identify solutions and / or make informed decisions. | Student groups will utilize technology in multiple forms in learning activity 4. Student groups will utilize the use of GPS units and digital SLR cameras with a macro lens will assist students in recording observations and performing non-lethal sample analysis, allowing for very precise digital documentation of evidence and procedures, and for the seamless uploading capability of qualitative evidence to the class Wiki website. Student groups will also utilize various layers of presentation software to present their groups work on the class Wiki, which will allow for student developed differentiation of content and artifacts. Student groups will present to the class from their Wiki pages using the SMART Board LCD interface. The teacher will be able to interact with student artifacts virtually on the web as well as through direct formative assessment of lab work and presentation. |

Instructional sequence

Activity 10.4 Introduction: accessing prior knowledge

Introduce the learning set and access prior knowledge by asking the students about the previous learning activity. Ask students: Was there evidence for natural selection in grasshopper populations we studied last week? Was there significant evidence that environmental factors may have played a role in the natural selection that may have occurred?

Student responses should include ideas such as: we found evidence of natural selection last week because there were different grasshoppers near the river versus away from the river. There were also different colors of grasshoppers as well as differences in legs and wings. Each population was different, and, within that population there were variations among various traits. I am not sure if we have evidence yet that environmental pollution played a role in the natural selection, however, we did find quite a bit of pollutants that could have affected the populations.

Direct students back to the various Wiki pages constructed in learning activity 10.3. Using the smart board review some of the presentations uploaded to the Wiki. Ask the students several questions. Would this change in trait happen immediately among the grasshoppers shown here? Is the population you encountered in your simulation changing because it wants to? Can individuals change traits in response to you preying upon them? Can they camouflage themselves so you will not get them next time?

Student responses should include ideas such as: The populations would change slowly over time, however, if I eat enough of them this year the population may be quite different next year. This trait won't happen overnight but maybe noticeable weeks after. The insects I ate can't change their color will not change next time, mostly because I ate them and they are there anymore.

Explain to students today that they will be examining many species of organisms that live along the Rouge River to determine if there is any differential survival and difference in traits. We will be analyzing whether or not there are differences in populations within a given forested area, or if the populations are very homogenous in diversity throughout the forested region. We will again be using very familiar technology today as well as some new technology. Each group will be presenting their field research methods today before we begin.

Activity 10.4 Introduction: introduce the Rouge River population sampling field experiment.

Explain to the students that they will be taking a lab field trip to the University of Michigan-Dearborn tomorrow to investigate natural selection through a predator prey simulation. The first part of the morning will included a one hour introduction to the various field sampling methods that are being used by the student groups. Explain to the students that the field research will incorporate the use of Nikon D3100 SLR cameras equipped with 18-270 Tamron Macro telephoto lens, Bower SD FN52 main and macro-ring flashes to be used to document the organisms they encounter. Explain that student groups will also be given one Garmin Rino-120 GPS unit to track the location that they encounter organisms, as well as, ensure that no groups become lost (these are the same tools from previous field work). Student groups will also utilize smart phones to aide in the identification of organisms they encounter. Today student groups will be maintaining safety procedures and no harm trekking tactics as well as group member monitoring. Student groups will be required to check in via radio once per half hour due to the large area being covered, therefore, adult supervisor for the group will always be with the group and require the each group leader to check in with the teacher at the required intervals.

Activity 10.4 Field experiments:

All student groups will be utilizing the Nikon digital cameras and related accessories utilized during activity two to document their progress and record the data. Student groups will also be using the Rino-GPS radio units to stay in touch and document location of research. Each student will also be required to record all field research and keep a journal of their activities in their field book. A field tree-camera has been placed in two primary locations, secondary and primary forested areas, two weeks prior to arriving. These cameras SD cards will be scanned for results by each group.

Students will be sampling organisms by using one of several approaches outlined in their field book (notes from class the day prior or morning of). The linear approach will require students to walk in a straight line for fifty feet and record all organisms found every 5-10 feet, whichever is possible. The hoop method requires students to drop a hula hoop down on the ground and examine all organisms they find within the area. The basic trek method allows students to walk and record the organisms they find visually over a 5 minute time period. The rope method has students rope off a larger area, which they will then examine the organisms found within the sectioned off area. Students will be only photographing, recording in field book, and sampling soil and water for later microscopic analysis.

Each student group is responsible for the entire region of the natural area. The group must choose the three locations they will studying by looking at the map just before trekking out. The student groups will then head out to perform their research and determine the best method of sampling based on the conditions of the areas they chose. Each sampling method lends itself to various environmental conditions as well as various organisms. Small organisms lend themselves to the hoop method, where as trees will require a linear approach. Smaller plant and animal species lend themselves to stringing off a larger area. No matter which methods are chosen, students must keep their results mathematical so statistical analyses can be performed later

Student groups will record all their data digitally and traditionally in their field books. Results will be brought back to the lab and analyzed. Student groups will be required to write a report on their results and construct scientific explanations based on the entire class analysis of data.

The student groups will then incorporate their results and lab reports to the Wiki, using Word and Excel to create final reports. Student groups will also utilize one other form of digital presentations to communicate their results to the class. Student groups will present their reports as a function of the Wiki website to the class utilizing the classroom interactive white board.

Activity 10.4 Cumulative Results Analysis:

Following the student presentations, begin a discussion that probes for understanding of the combined results from the entire class. Construct a whole class Wiki page that includes all the photographic representations of the sampling methods, organisms discovered, microscopic organisms, area photographs, etc. Student groups will be responsible for uploading their photographs and descriptions to the specified Wiki webpage. The students can then utilize the whole class data to construct various natural selection events that may have occurred over the last 400 years in the area (the primary forest is about 400 years old. Student groups would be responsible for creating a scientific explanation of why several traits identified were chosen for survival based on the various factors explored during the field experiment. Students would need to create a scientific explanation about their findings with respect to distance from the river. Students should be answering the basic questions that answer whether or not there is a difference in organisms with respect to distance from the river. Are these differences based on natural selection and if so what selection factor would possibly be the reason for their results?

Activity 10.4 Concluding Discussions:

Discuss the possible natural selection events that students have come up with. Allow time for all groups to report and create a class Prezi or basic chart on Excel showing the various student brainstormed environmental conditions that may have caused the differential survival. Ask the students if we have obtained evidence that may help us answer the driving questions: **1) What evidence did we collect that supports the major concepts of natural selection with respect to the River Rouge grasshopper populations? 2)What genetic variations are present in the grasshopper populations, and is there evidence that some of those traits are trending toward preservation or elimination? 3) Is there evidence to support a theory that environmental conditions in the River Rouge Watershed are leading to differential survival and reproduction of chance inherited variations in grasshopper traits, or, other organisms?**

Student answers will vary based upon the factors they uncover in the field.

Activity 10.4 Teacher Content Knowledge:

The content in learning activity 4 is a very familiar subject matter to me. This particular activity is an adaptation of an experiment that I performed years ago in Northville at River Rouge park for undergraduate work, in a more student designed and technologically advanced format. Teachers must complete several visits to the area prior to arriving just to get to know the different components of the 70 acres. Conceptual knowledge is not enough because of the enormous size of the area. Teachers would also benefit from a deep understanding of all organisms that inhabit the area, or at least have access to websites that can identify the organisms. Such websites will also be necessary for students groups to identify individual organisms. In addition, it may be beneficial to the flow of the activity to have taken two prior trips to the Center. Student trips in Fall and Winter will set-up a great activity in the spring when life is popping in the area. The teacher may also want to contact the University of Michigan-Dearborn professor teaching either population genetics or field biology. They could possibly provide college student assistants for the research project.

Activity 10.4 Teacher Pedagogical Knowledge:

Learning activity 4 utilizes small group field work, small group formative assessment techniques, whole group discussion, integration of technology, Field Biology techniques, proper trekking techniques, no-harm examination, computer integration techniques, digital macro photography techniques, website development, digital communication applications, as well as midpoint discussion and assessment. Teachers must become fluent in the use of the Nikon D3100 and attachments, Garmin Rino-120 GPS, related geocaching techniques, GPS locating techniques, field sampling techniques. Teachers must also be fluent in differentiation of material to various student levels so the creation of learning centers can be efficient and effective in increasing understanding of concepts. The use of these pedagogical techniques is paramount in today's digital world. Scientists communicate results digitally through online journals and share data via email, blogs, and interactive video conferencing. Also, laboratory field work is a wonderful opportunity for students to incorporate and apply what they have learned throughout the unit.

Activity 10.4 Teacher Technology Knowledge:

The technology used in learning activity 3 requires prior use and access before teaching the lessons. Teachers must have prior experience with Digital SLR photography and related attachments before ever trying to allow students to work with them. Teachers must also become extremely familiar with the GPS technology and how to locate students groups using the Rino-120 before allowing students to trek around a 70 acre natural area or rivers edge. Familiarization with MacBook Air photographic and video editing programs is a must. The use and classroom licensing of Prezi, Story Board, and GoAnime is required before the lesson can be taught. Teachers must be fluent with interactive white boards and LCD projection as well as the subsequent analysis of student technological presentation evaluation. Teachers will also have to familiarize themselves with the use and placement of tree-cameras.

Activity 10.4 TPACK Analysis:

An inquiry based approach to learning Science concepts, connected with thoughtful and thorough discussion, is a very acceptable approach in Science Pedagogy. Current research from the University of Michigan and other Universities support such inquiry and discussion as one of the best methods of Science instruction at the K-12 level. The digital technologies used in this activity are highly engaging and current with today's youth. The project is field-based using components from the digital world, which is a good application of what scientists may use in today's science field. Activity three also includes the use of low and high-tech scientific tools such as testing probes and water sampling devices. The use of both together gives the students great advantage in understanding the technical aspects of scientific field research methods.

Activity 10.4 Assessment Plan:

Student learning will be assessed on presentations that incorporate all qualitative and quantitative evidence from the field research, that supports natural selection through environmental and ecosystem conditions causing differential survival and reproduction of chance inherited variants. The student groups are responsible for collecting results and recording them digitally. Groups are also responsible for the development of several digital communication artifacts that lead to the development of the class Wiki website pages that refer to grasshopper field research. The following scoring rubric will be utilized to assess the performance quantitatively:

|  |  |  |  |
| --- | --- | --- | --- |
| Student subtask | Weak artifact development | Acceptable artifact development | Strong artifact development |
| Field-work qualitative and quantitative evidence | 1 | 2 | 3 |
| IT-Presentation artifacts and organism photography with identification | 1 | 2 | 3 |
| Oral presentations | 1 | 3 | 5 |
| Wiki development | 1 | 3 | 5 |

Activity 10.4: Assessment Questions: In addition to the technological artifacts created during learning activity 4, students will be asked to answer some application questions. Student questions are attached and so are scoring rubrics.

1) Explain why as the distance from the river increased there was a variation in the species of trees recorded. Please include the concepts of differential survival and reproduction in your answer. Support your answer with three specific examples from your field work. Use no more than 30 words to complete this. (6 pts)

Tentative point allocation for each form

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Student subtasks | Weak response including only one supporting example with no reasoning using scientific principles | Acceptable response including two supporting examples and good reasoning using scientific principles | Strong response including three supporting examples and excellent reasoning using scientific principles | Total Points |
| Explanation of Natural Selection based on variation in reproduction techniques of tree species. | 1 | 1 | 1 | 3 |
| Use of three supporting examples from field-work | 1 | 1 | 1 | 3 |

2) Describe your sampling methods in the field experiment. Explain what factors inhibited you from using other sampling techniques in certain situations. Support your answer with three specific examples from your field work. Use no more than 30 words to complete this task. (6 pts)

Tentative point allocation for each form

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Student subtasks | Weak response including only one supporting example with no reasoning using scientific principles | Acceptable response including two supporting examples and good reasoning using scientific principles | Strong response including three supporting examples and excellent reasoning using scientific principles | Total Points |
| Explanation of sampling techniques and why some are better than others for certain studies. | 1 | 1 | 1 | 3 |
| Use of three supporting examples from field-work | 1 | 1 | 1 | 3 |

3) Researchers set up camp in Chicago's inner-city areas to study the affect urban life has had on Chicago's burgeoning raccoon populations. To the researchers astonishment inner-city raccoon populations were becoming very adapt to living within the cities' human-packed limits. While many other wild animals numbers became severely diminished raccoons flourished. The current hypothesis is the raccoons ability to eat and digest an extremely wide array of food products similar to humans. Another hypothesis believes that the raccoon populations are actually becoming smarter and better apt at finding food and shelter, when compared to their forest dwelling counterparts. (8 pts, use additional paper if necessary)

* Please explain the hypothesis you agree with the most (or both) and why you agree with it based on what you have learned about natural selection.
* Please explain how the hypothesis you chose might actually cause differential survival of Chicago City raccoons.
* Please explain what evidence you believe the researchers should be collecting about the raccoons and their environment that might be helpful in better understanding the natural selection that may be occurring in the raccoon populations.

b) Tentative scoring key:

Tentative point allocation

|  |  |  |  |
| --- | --- | --- | --- |
| Student subtasks | Weak response | Acceptable response | Strong response |
| Explain what hypothesis they agree with and why. | 0 | 1 | 2 |
| Explain how the hypothesis they chose may lend itself to natural selection in the raccoon populations. | 0 | 1 | 2 |
| Explain what other evidence may reveal natural selection in the raccoon population. | 0 | 1 | 2 |